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CELL SCIENTISTS TO WATCH

Cell scientist to watch – Géraldine Laloux

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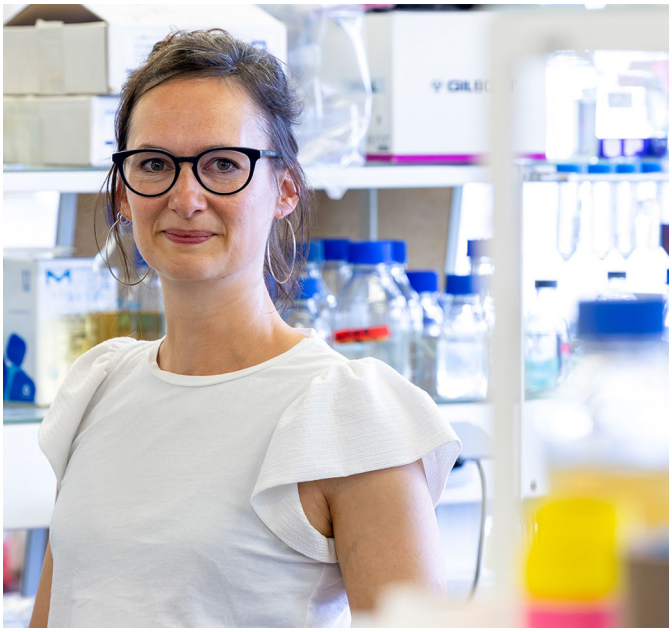
Géraldine Laloux is an Associate Professor of bacterial cell biology at the de Duve Institute, UCLouvain, Belgium. After studying host–pathogen interactions during her PhD at the University of Namur, Belgium, Géraldine focused more on the cell biology of bacteria when she joined the Jacobs-Wagner lab at Yale University, USA. In 2017, she then returned to Belgium to set up her lab at UCLouvain, where she works with predatory bacteria to study their unusual cell cycle mechanisms and underlying cellular organisation. We caught up with Géraldine over Zoom to find out more about the interesting lifestyle of these predatory bacteria, as well as her approaches to mentoring and starting a new lab.



Géraldine Laloux. Photo credit: Jan Van De Vel, RED22, Institut de Duve.

What first sparked your interest in science, and more specifically, bacterial cell biology?

It started with an interest in mathematics and chemistry at high school, even more so than biology. But when I started to think about my future studies, I realised that biology is a nice mixture of mathematics, chemistry and physics, and brings everything together to make something even more complex work, like a cell or an organism; I thought it was fascinating. Then, I think my interest for bacterial cell biology came a bit later, because at first, I completely fell in love with molecular biology and yeast genetics, mostly thanks to this fantastic teacher, Jean Vandenhaute, who was good at conveying the history of molecular biology and genetics, and how interesting this was. So, I decided to do my master's thesis working with yeast, genetics and protein–protein interactions in the lab of Marc Vidal in Boston. I then shifted to microbiology during my PhD with Xavier De Bolle, which focused on host–pathogen interactions. But, in that lab, there were other people working on the pathogen, not from the perspective of finding virulence factors or effectors, but from the perspective of understanding the cell biology of that bacterium. I thought this was even more exciting, and this is how I was exposed to the papers from Christine Jacobs-Wagner's lab describing the amazing organization of bacterial cells and the cell cycle in bacteria. So, I decided to contact Christine for a postdoc, and that is where I ended up!

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What would you say are the most important or interesting questions in the field of bacterial cell biology right now?

What's most important now and interesting in the field is to go beyond the textbook models; there is so much that has been discovered in bacterial cell biology in the past 20 years or more, but these findings are mostly from a few model species, for example, *Caulobacter*, *Bacillus* and *E. coli*. There are very important findings made with these species, and even general rules about bacterial replication that emerged from these studies. But bacterial diversity is huge, and this is becoming more and more appreciated. It turns out that not all the general rules apply to all species, which means that there are many more mechanisms of cell cycle control and intracellular organisation, for example, that still need to be discovered. I think this is one of the most attractive questions to me in bacterial cell biology, hence why I decided to work with a 'non-canonical' organism.

Another aspect is that now we are at a point where microscopy has improved so much, we can go to super resolution and visualise these beautiful protein structures, and monitor and measure multicellular behaviours, but linking all these aspects together across different scales, from the protein structure to the multicellular or interspecies interaction level, this is really the challenge now. How do these proteins interact together in time and space? And how do these dynamic interactions lead to a particular behaviour or process in the cell and how does this process then contribute to the overall functioning of the cell? The links between these different levels are still super challenging to assess, but an exciting challenge, nonetheless.

After completing your PhD at the University of Namur, Belgium, you moved to the USA for a postdoc in Christine Jacobs-Wagner's lab at Yale University – what were the best and most difficult aspects of moving abroad during your career?

Although Yale is a prestigious university, I chose Christine's lab because of her science, and it was also fantastic because I met so

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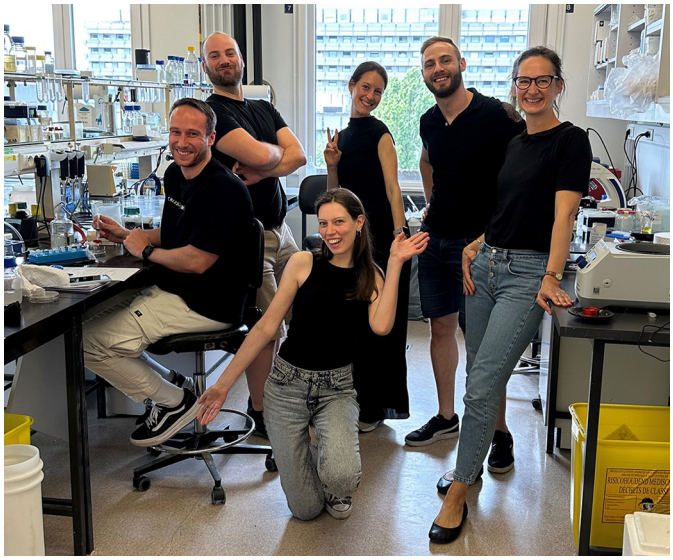

The Laloux lab. From left to right: Yvann Bourigault (Postdoc), Charles de Pierpont (Research Technician), Ophélie Remy (PhD student), Jovana Kaljević (PhD student), Yoann Santin (Postdoc), Géraldine Laloux. Not on this picture: Renske van Raaphorst (Postdoc) and Coralie Tesseur (PhD student).

many people from different fields. Not only in bacteriology, but we were in this department of molecular, cellular and developmental biology. So, there were people working on plants, flies, zebrafish, you name it. So, I would say that the best aspect of moving abroad is that you get to be part of an international community of researchers from a range of backgrounds. Regarding the move, living in the US is a very distinct experience from our European life and I guess was maybe one of the difficult parts, because after a while I was missing the European way of life a bit. This was partly personal, as I was in a long-distance relationship for three and a half years with my partner, which worked out though, because he is now the father of my kids!

You then moved back to Belgium for a postdoc with Jean-Francois Collet at UCLouvain – what did your research focus on here?

In the lab of Jean-Francois Collet, I focused on the bacterial envelope of *E. coli*, trying to answer basic questions like 'how is this envelope built?' and 'how does it cope with damage and stress?'. These are important questions because the envelope is the first layer of protection for the cell in the environment. At first, I was a bit out of my comfort zone, because until then, I had only focused on cytoplasmic questions, and for me, the envelope was just the border of the cell. But then I discovered that there are so many things going on there that are actually very important, so it turned out to be a lot of fun. And this was in a lab that has strong expertise in biochemistry, which is something I missed a bit in my previous path, and so I learned a lot from them, especially in terms of trying to understand protein–protein interactions at a much deeper level. But what I tried to do was to bring my cell biology perspective to the questions that the lab was addressing; simply by looking at my cells under the microscope, I could analyse all these mutants with cell envelope defects or stress response defects. For me, it was natural to look at them under the microscope if they did not grow like the wild-type strain, and this was not the approach that they were using before because they would go directly to the biochemistry. So, by bringing this approach, I think it helped me to discover some interesting aspects of the cell envelope, which allowed me to start publishing as a leading author on some papers and merge my previous expertise with those already in the lab.

In 2017 you then started your own lab at the de Duve Institute, Belgium, where your research focuses on predatory bacteria; what are predatory bacteria and what fascinates you the most about them?

Predatory bacteria feed upon other bacteria, killing them in the process. The bacteria that we study in the lab are obligate predators, which means that they need to feed upon another cell to grow and to divide. But what really got me interested in these bacteria is not only that they proliferate inside another bacterium, but the way that they grow and divide; this is not done by the usual mechanism of doubling their size and dividing in the middle to make two cells. They undergo long filamentous growth and then divide at multiple places along that filament, releasing many daughter cells, the number of which is highly variable. To me, this was so unexpected and intriguing, because it challenges many of these 'general' rules of bacterial proliferation, i.e. in terms of regulating cell division, replicating and segregating chromosomes, establishing cell polarity etc. This raises many questions and is why predatory bacteria were so attractive to me when I started.

What specific questions about predatory bacteria does your research focus on?

Using the predatory bacterium, *Bdellovibrio bacteriovorus*, we are trying to understand how the cell cycle is regulated during its 'non-canonical' cell division, including how the chromosome is organised, replicated and segregated in space, and how polarity is established. We are also interested in how the bacterium knows when to stop growing and to start dividing; we know that the size of the prey is important, and this is a story that we published recently, but we don't know the molecular signals that the bacteria sense to trigger division. Ultimately, we would also love to understand how the prey impacts the cell cycle of the predator. In the future, we can also expand our research to other predators that feature other feeding and proliferation strategies, looking at their similarities and differences from a genomic perspective. This could help us to identify how and why their cell cycles are regulated so differently, based on how they predate.

You describe the model predatory bacterium you work with, *Bdellovibrio bacteriovorus*, as being a 'non-canonical' species – how does this impact on your research both in and outside the lab?

Inside the lab, the fact that these bacteria feed on other bacteria of course means we need to work with them differently compared to free-living species. So, instead of using growth medium to cultivate them, we use a suspension of *E. coli* cells that they will feed upon. We also have to think about the experiments differently whenever we do genetics, for example, as the prey that we use has to be resistant to the selective pressure (antibiotic) that we apply. But this is the same whenever you change model organism; even if you go from *E. coli* to *Bacillus,* there are always different tips and tricks that you need to acquire. But this is all part of our routine now, and so it's not a problem to work with them anymore.

Outside the lab, I think it has quite a positive impact; the fact that we work with this non-canonical bacterium gives us an opportunity to open the perspective of other biologists and bacterial cell biologists to show them that some dogmas are not necessarily universal. But I think my main goal in this respect is to show that it can be a model to study other strategies and molecular mechanisms

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of intracellular organisation and the cell cycle in bacteria. Although it's a fun bacterium to watch, and people are always excited when they see a video of *B. bacteriovorus* dividing, I want to bring this species beyond being anecdotal. I would really love to show that using this non-canonical bacterium can be a very nice tool to discover new principles of cellular organisation.

What challenges did you face when starting your own lab that you didn't expect?

There were many challenges that I was expecting because people had told me about the challenges of managing a team, hiring people, purchasing expensive equipment etc., which you are not necessarily trained in doing. But so far, I feel that I've been pretty lucky, both with the team and the installation of my lab in the de Duve Institute. I think I've benefited a lot from the support from my previous mentors and colleagues here who were very helpful. So, nothing unexpected, and these are things you learn on the job. Although there are a lot of training opportunities in the university for teaching, mentoring and management skills, you can go to as many workshops as you want, you will never learn more than when you experience it yourself.

I try to do my best to mentor my lab members in a way that, hopefully, they become independent in their scientific path

How important would you say mentorship has been for your career? What is your approach to mentoring your lab members?

For me, it was extremely important. I was very lucky that at every stage; from my master's thesis to now, I have had super supportive Principal Investigators (PIs). They also told me from the very beginning, each in their different way, that building a network is important; having a PI who is well connected helps give you opportunities from a very early stage. And it's important to make the most of these opportunities. Then in terms of the research, my previous PIs all had different, sometimes opposite, ways of managing the lab or the science. They all have their own benefits, and I've been able to take some ingredients from each to try and make my own recipe. I try to do my best to mentor my lab members in a way that, hopefully, they become independent in their scientific path, and I would also like them to become well connected. I think this is really important in the future, whether they want to stay in academia or not.

Speaking of connecting with people, I see you and your lab regularly attend and present at conferences, including the recent Belgian Society for Microbiology conference. What is your approach to conferences and what would you say is most valuable about attending them?

There are many advantages to attending conferences. One is networking; I still know some of the people I met when I was very early in my career, which is really useful. Aside from networking, it is important that you are exposed to the amazing science being done everywhere in the world, and to find out what topics people get excited about. This is better than a journal club or reading papers on your computer. In just one week, you obtain this massive amount of information about so much exciting science. So, I really try to encourage my students and postdocs to go to at least one international conference per year. And we also have national conferences here; for example, the Belgian Society for Microbiology, which is really great, because despite being a very small country, there's a very active microbiology community. And it's important to be connected not only across the ocean, but also within the local community. Finally, practicing communicating research is important; presenting a poster or a short talk is a great exercise. Watching PhD students presenting their work on several occasions, and improving every time, is very rewarding.

Finally, could you tell us an interesting fact about yourself that people wouldn't know by looking at your CV?

I practice yoga a lot. I think it helps to feel good in your body, and feel good in your mind, and then hopefully the people in my lab also benefit from that. Another thing is that I learned to play classical piano for 10 years at music school, and I still practice on the piano at home. Last but not least, as a good Belgian citizen, I appreciate good beers.

Géraldine Laloux was interviewed by Daniel Routledge, Cross-title Reviews Editor for The Company of Biologists. This piece has been edited and condensed with approval from the interviewee.